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Investigation of Archived Gamma Data to Report Minimum Detectable Activities for Gamma-Emitting Radionuclides in Groundwater Samples

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Introduction

Los Alamos National Laboratory (LANL) has performed gamma analyses on ground water samples from the Nevada National Security Site (NNSS) (previously known as the Nevada Test Site or NTS) for the last 50 years. During that time, LANL has reported all of the detected radionuclides in various reports, letters and publications. However, until recently, no minimum detectable activities (MDAs) for undetected radionuclides of interest have been reported. In fact, most gamma emitting radionuclides were not detected in groundwater samples above their respective MDAs, and the MDAs can be used to define upper-bound activities for these radionuclides in the groundwater samples. The MDAs in each sample can, in turn, be compared to the respective maximum contaminant levels (MCLs) for each radionuclide. This study documents the MDAs for gamma emitting radionuclides in groundwater samples so that the information can be captured in UGTA project databases, and compares the MDAs to the respective MCLs.

The list of radionuclides of interest for the Underground Test Area (UGTA) activity are found in a report from Finnegan et al. (2016) "Nevada National Security Site Underground Radionuclide Inventory, 1951-1992," which is a summary of all of the radionuclide activity produced by underground testing at the NNSS. Table 1 is reproduced from Table 1 of Finnegan et al., (2016). The table lists the current values of MCL's, which were obtained from *Radionuclides in Drinking Water: A Small Entity Compliance Guide* (EPA, 2002). For radionuclides with no MCLs defined in the EPA 2002 document, equivalent values were calculated using RESRAD Version 6.5 (Yu et al., 2001) as documented by Finnegan et al., (2016). RESRAD is a computer model designed at Argonne National Laboratory to estimate radiation doses and risks from residual radioactive materials. The MCL calculated using RESRAD is that concentration in drinking water that will impart a dose of 4 mrem/year to a person drinking an average of 2 liters of water per day. We note that there are no MCLs listed in Table 1 for ^{39}Ar and ^{85}Kr because these two radionuclides are gases. When the water is underground, high pressure keeps ^{39}Ar and ^{85}Kr in groundwater, but when the water is brought to the surface, both radionuclides are released to the atmosphere. These radionuclides are retained in the inventory, however, to be complete. Table 1 also includes the principal radiochemical sources or production mechanisms of test-derived radionuclides. Where multiple sources are identified, each is listed. The list of radionuclides included in this inventory evaluation remains the same as in the previous analysis (Finnegan et al., 2016).

Table 1

Radionuclides Included in the Source-Term Inventory

(MCL from U.S. Environmental Protection Agency (EPA, 2002) or calculated using RESRAD)

Element	Nuclide	Half-life (y)*	MCL (pCi/L)	Main Source(s)
Hydrogen	^{3}H	12.32	2.0×10^{4}	device component; ^{6}Li (n,α) T
Carbon	^{14}C	5715	2.0×10^{3}	^{14}N (n,p); ^{13}C (n,γ); ^{17}O (n,α)
Aluminum	$^{26}A1$	7.1×10^{5}	$4.2 \times 10^{2**}$	$^{27}A1$ (n,2n)
Chlorine	$^{36}C1$	3.01×10^{5}	7.0×10^{2}	$^{35}C1$ (n,γ); ^{39}K (n,α)
Argon	^{39}Ar	269	----	^{39}K (n,p); ^{38}Ar(n,γ)
Potassium	^{40}K	1.27×10^{9}	$2.4 \times 10^{2**}$	Natural
Calcium	^{41}Ca	1.03×10^{5}	$7.8 \times 10^{3**}$	^{40}Ca (n,γ)
Nickel	^{59}Ni	7.6×10^{4}	3.0×10^{2}	^{58}Ni (n,γ)
	^{63}Ni	101	5.0×10^{1}	^{62}Ni (n,γ), ^{64}Ni (n,2n), ^{63}Cu (n,p)
Krypton	^{85}Kr	10.76	----	FP; ^{84}Kr (n,γ)
Strontium	^{90}Sr	28.78	8.0×10^{0}	FP
Zirconium	^{93}Zr	1.5×10^{6}	2.0×10^{3}	FP; ^{92}Zr (n,γ); ^{94}Zr (n,2n)
Niobium	^{93m}Nb	16.1	$1.2 \times 10^{4**}$	^{93}Nb (n,n′)
	^{94}Nb	2.0×10^{4}	$8.7 \times 10^{2**}$	FP; ^{93}Nb(n,γ)
Technetium	^{99}Tc	2.13×10^{5}	9.0×10^{2}	FP; ^{99}Ru (n,p)
Palladium	^{107}Pd	6.5×10^{6}	$4.0 \times 10^{4**}$	FP; ^{106}Pd (n,γ)
Cadmium	^{113m}Cd	14.1	$6.4 \times 10^{1**}$	FP
Tin	^{121m}Sn	44	$3.9 \times 10^{3**}$	FP; ^{120}Sn (n,γ)
	^{126}Sn	2.3×10^{5}	$3.2 \times 10^{2**}$	FP
Iodine	^{129}I	1.57×10^{7}	1.0×10^{0}	FP; ^{129}Xe (n,p)
Cesium	^{135}Cs	2.3×10^{6}	9.0×10^{2}	FP
	^{137}Cs	30.07	2.0×10^{2}	FP; ^{137}Ba (n,p)
Samarium	^{151}Sm	90	1.0×10^{3}	FP; ^{150}Sm (n,γ)
Europium	^{150}Eu	36	$1.1 \times 10^{3**}$	^{151}Eu (n,2n)
	^{152}Eu	13.54	2.0×10^{2}	FP, ^{151}Eu (n,γ); ^{153}Eu (n,2n)
	^{154}Eu	8.593	6.0×10^{1}	^{153}Eu (n,γ)
Holmium	^{166m}Ho	1.2×10^{3}	$7.4 \times 10^{2**}$	FP; ^{165}Ho (n,γ)
Thorium	^{232}Th	1.40×10^{10}	1.5×10^{1}	natural and device component
Uranium	^{232}U	69.8	6.7×10^{8}	device component; ^{233}U (n,2n)
	^{233}U	1.592×10^{5}	2.9×10^{5}	device component; radchem tracer
	^{234}U	2.46×10^{5}	1.9×10^{5}	natural and device component
	^{235}U	7.04×10^{8}	6.5×10^{1}	natural and device component
	^{236}U	2.342×10^{7}	1.9×10^{3}	device component; ^{235}U (n,γ); ^{238}U $(n,2n)^{2}$
	^{238}U	4.47×10^{9}	1.0×10^{1}	natural and device component
Neptunium	^{237}Np	2.14×10^{6}	1.5×10^{1}	radchem tracer; decay of ^{237}U
Plutonium	^{238}Pu	87.7	1.5×10^{1}	device component; radchem tracer; ^{239}Pu (n,2n); ^{237}Np (n,γ)
	^{239}Pu	2.410×10^{4}	1.5×10^{1}	device component; decay of ^{239}U
	^{240}Pu	6.56×10^{3}	1.5×10^{1}	device component; ^{239}Pu (n,γ); decay of ^{240}U
	^{241}Pu	14.4	3.0×10^{2}	device component; ^{240}Pu (n,γ); decay of ^{241}U
	^{242}Pu	3.75×10^{5}	1.5×10^{1}	device component; radchem tracer; ^{241}Pu (n,γ); decay of ^{242}U
Americium	^{241}Am	432.7	1.5×10^{1}	device component; radchem tracer; decay of ^{241}Pu
	^{243}Am	7.37×10^{3}	1.5×10^{1}	device component; radchem tracer
Curium	^{244}Cm	18.1	1.5×10^{1}	radchem tracer

* Half-lives obtained from GE Chart of the Nuclides, Sixteenth Edition (2002).

**MCL from RESRAD calculations

Samples Analyzed

There is interest within the UGTA activity to determine which radionuclides from the inventory should be considered when modeling the movement of radionuclides from test cavities into the surrounding groundwater aquifers in order to calculate contaminant boundaries. Because most of these radionuclides have never been detected in cavity waters, it might be reasonable to exclude some of them from the contaminant boundary calculations by comparing MDAs for radionuclides that have previously been reported as undetected in sample analysis to the respective MCLs (maximum concentration limits). This study reviewed and tabulated the MDAs for the gamma data for groundwater samples from hot wells for the radionuclides listed in Table 1 of the Finnegan et al. (2016) report (above). MCLs for many radionuclides have never been exceeded in test cavities. LANL MDAs for many of the gamma-emitting radionuclides in the inventory are well below the MCLs. If the MCLs are not exceeded in representative cavities sampled over the past 50 years, it is a reasonable assumption that it is unlikely for those radionuclides to exceed the MCLs in water at the NNSS, and the radionuclides may potentially therefore be dropped from consideration during transport modeling. In this discussion, the MDA values are compared to the EPA MCLs, and the estimated MCL calculated using RESRAD, as described above. ^{137}Cs has appropriate gammas, however, it is routinely detected in water near test cavities, so it is not included in this study because actual sample (detected) concentrations can be used rather than the MDAs.

Seventeen different sampling locations are included in this study.

- There are 12 wells associated with 9 underground nuclear tests, which are often referred to as hot wells. The tests are ALMENDRO, BILBY, BULLION, CAMBRIC, CAMEMBERT, CHANCELLOR, CHESHIRE, DALHART, and TYBO/BENHAM. The water samples that are associated with nuclear tests were collected either from or near the test cavity or chimney. The exception is TYBO/BENHAM where the ER-20-5 #1 and #3 wells are 280 m from TYBO and ~ 1 km from the BENHAM test cavities.
- Two wells are monitoring wells located near Rainier Mesa, ER-12-2 and ER-12-3. These two wells are not hot wells.
- Two other sampling locations are associated with tunnel areas at the NNSS, and these samples are of impounded tunnel water from U-12n tunnel and U-12t tunnel.

The approach is to determine the MDAs for radionuclides reported as undetected in most of the hot well and tunnel samples, and compare those MDAs to the MCLs. This analysis provides more information about the samples than the simple results showing that the radionuclide was not detected, because the quantitative MDA is directly compared to the MCL to determine if the sample concentration is less than the MCL. Originally, this study was designed to exclusively look at data from drill backs that sampled directly from test cavities, but because of difficulties with classification issues, only unclassified sample data were used, and only a few are directly from test cavities. A total of 35 samples was used in this study. A brief summary for each site is presented below to provide context for conditions at each sampling location, including the applicable nuclear test and the wells that were sampled. Static water level (SWL) information is approximate and provided for the test location when the test was conducted (i.e., pre-shot

condition). The summary information was obtained from several annual reports for LANL's water sampling in support of UGTA and the Hydrologic Resources Management Program (e.g., Thompson et al., 2000; Finnegan and Thompson, 2003, Finnegan et al., 2004; Finnegan et al. 2005 and earlier reports).

ALMENDRO (U-19v PS 1D)

Fired: 6 Jun 73
DOB: 1066 m (in rhyolite)
SWL: 686 m (bgs)
Yield: 200-1000 kT

U-19v PS 1D is a post shot hole that samples within the ALMENDRO cavity. Water levels in U-19v PS 1D rose from 1000 m to 768 m below ground surface (bgs) from Sep 1973 to Sep 1979. The temperature of the water in Sep 1979 was ~226 C° at 1164 m (bgs). In Dec 1996, the water level had risen to 718 m bgs and the temp was 157 C° at 1106 m bgs. No pump was put in the hole, so all samples were bailed. Measured radioactivity in Sep 1979 was as follows: ^{3}H ~2 x 10^{8} pCi/L; ^{85}Kr ~ 5 x 10^{4} pCi/L; ^{137}Cs ~ 3 x 10^{0} pCi/L; ^{60}Co ~ trace amounts. The activity levels were approximately the same in 1993 and 1996. This shot was unusual because of the thermal conditions, apparently from slow circulation. This condition may lead to a higher dissolution of the melt glass. Gamma spectra were available for a combined set of bailed samples collected at 942 m bgs in September 2000, and MDAs for that sample are included in this study.

BILBY (U-3cn ps#2, U-3cn#5)

Fired: 13 Sep 63
DOB: 714 m (casing to ~60 m from paleozoics)
SWL: 503 m (bgs)
Yield: 249 kT

U-3cn ps#2 post shot hole crimped in 1963 preventing access to the lower chimney and cavity regions. A packer was set at 561 m bgs, perforations were put in at 512 and 527 m and a pump was installed that samples from the top of the chimney. The hole was pumped periodically until 1981 and then again in 1997, 2001 and 2004. The 1997, 2001 and 2004 samples showed ^{3}H and ^{137}Cs. MDAs for these three later samples are presented in this study.

U-3cn#5 is 122 m S of Bilby and 922 m deep. It is cased to draw water only from the carbonate aquifer. It was pumped from 1967-69, 1969-73, 1979-81, 1997 and 2000. No ^{3}H or other radionuclides were found in the water.

BULLION (ER-20-6#1, ER-20-6#2, ER-20-6#3)

Fired: 13 Jun 90
DOB: 674 m (in tuff – cavity may extend into the rhyolites)
SWL: 619 m (bgs)
Yield: 20-150 kT

A 4-$^1/_2$" pipe was put into hole U20bd after post-shot drilling in June 1990. The hole extended through the cavity to below the WP. In Oct 1990, the pipe was found to have been sheared just below the water level, therefore no access to the cavity was possible.

BULLION became the site of the forced gradient experiment conducted by the UGTA activity from June - August, 1997. Wells ER-20-6 #1, #2, #3 were drilled to the SW, supposedly down gradient of BULLION, at distances of ~166 m, ~207 m and ~296 m respectively. Pipes with screens were emplaced to draw waters from depths between 765 to 884 m bgs, appreciably below the WP. Some ^{3}H was encountered during drilling and just after purging in spring, 1996. In Nov and Dec 1996, very little activity was found in #1 and #2 holes and none in #3. Pumping during the forced gradient experiment yielded samples with detectable tritium but no detectable gamma-emitting radionuclides. MDAs for the spectra for the 1996 samples collected at these three wells are included in this report.

CAMBRIC (RNM-1)

Fired: 14 May 65
DOB: 295 m
SWL: 213 m (bgs)
Yield: 0.75 kT

RNM-1 was drilled into the CAMBRIC test cavity 10 years after the test to sample radionuclides. ^{3}H, ^{85}Kr, ^{90}Sr, ^{106}Ru, ^{125}Sb, ^{137}Cs, and very slight amounts of ^{144}Ce and ^{239}Pu were detected in the water from RNM-1. In the solids, the same radionuclides plus ^{147}Pm, ^{155}Eu and ^{241}Am were detected. Refractory materials were concentrated in the cavity region, while volatiles were depleted there. For this study, MDAs for three groundwater samples collected from the CAMBRIC test cavity using RNM-1, collected in Sept 1994, Jun 2000, and Jun 2004, are provided because the samples are collected from the test cavity.

RNM-2s was drilled at a distance of 91 m south of the working point. Pumping of RNM-2s was started in Oct 75 and continued until Aug 91. A total of 16.9×10^6 m^3 of water was pumped from the well. ^{3}H and ^{85}Kr were pumped out in a classical elution curve. ^{106}Ru and ^{125}Sb has $t_{1/2}$ too short for measurement; ^{36}Cl, ^{129}I, and ^{99}Tc, were initially detected in the water but were eventually pumped out to below detection limits. No Cs, Sr or Pu isotopes (cationic species) were detected in RNM-2s waters.

This location was LANL's first field test experiment which gave rise to our understanding of transport of anionic *vs.* cationic species, demonstrated the utility of ^{3}H as a tracer and showed refractory *vs.* volatile distribution in the cavity.

CAMEMBERT (U-19q PS 1D)

Fired: 26 Jun 75
DOB: 1312 m
SWL: 668 m (bgs)
Yield: 200-1000 kT

The Camembert event was fired on June 26, 1975 at a depth of 1310 m bgs, which was well below the water table at 668 m bgs. The test was drilled back within days after the detonation by the test program and well U-19q PS 1D was left open. In September of 1998, UGTA found the drill back hole to be open to a slant depth of 1120 m bgs. A pump was inserted to a slant depth of 916 m and water was pumped at ~ 10 gal/min for a little more than a week. The sampling was done ~180 m above the cavity, and ^{3}H and ^{137}Cs were detected in the water. MDAs for spectra of samples collected at this location in Oct 1998 and Jul 2003 are presented in this report.

CHANCELLOR (U-19ad PS 1A)

Fired: 01 Sep 83
DOB: 624 m
SWL: 682 m (bgs)
Yield: 143 kT

Well U-19ad PS 1A is located within Central Pahute Mesa in Area 19 of the NNSS, and is part of the investigation of Corrective Action Unit 101. U-19ad PS 1A is located approximately 265 m south of the emplacement hole U-19ad.

The well was drilled to a total depth of 795 m bgs, well below the water level of 682 m
The purpose of U-19ad PS 1A for the UGTA activity was to provide scientific data regarding aqueous geochemistry, radiochemistry, and hydrogeologic character of the subsurface in the area of underground testing. Data acquired as part of the development and sampling work support ongoing flow and transport modeling efforts. Several RNs (^{3}H, ^{90}Sr, ^{129}I, ^{137}Cs, and $^{239/240}Pu$) exceeded their MCLs in samples collected from U-19ad PS 1A in 2008. MDAs for spectra of samples collected at this location in Sept 2004 and May 2008 are presented in this report.

CHESHIRE (U-20n PS-1DDh; UE-20n #1)

Fired: 14 Feb 76
DOB: 1167 m
SWL: 625 m (bgs)
Yield: 200-500 kT

Experimental work in U-20n PS-1DDh began on 21 Jun 76 (T_o + 128 days). Water was still in-filling the cavity at that time. A liner was put in the hole and was perforated at 1322-1358 m bgs (which was below the working point), and the water was sampled. LANL attempted to move the pump in the hole and it stuck. It was 1983 before more water samples were collected, this time at a depth of 1281-1306 m bgs, in the chimney region. This depth was sampled from 1983 to May 1985 and a total of 1.3 x 10^4 m^3 of water was pumped. The radionuclides detected in the water were ^{3}H and isotopes of Na, K, Mn, Co, Kr, Sr, Ru, Sb, Cs, Ce, Eu, and Pu. The pump was moved up the hole, the liner was perforated from 812-913 m bgs, and samples were collected. While ^{3}H, Kr, and Sb showed little change, Sr, Cs, Co and Eu showed large drops in concentration. There was some association of Co and Eu with colloids.

In August and September of 1998, the liner in U-20n PS-1DDh was configured to allow water samples to be withdrawn from the cavity horizon. The plug at 945 m slant depth was milled out; the liner was perforated over the interval 1244 to 1253 m slant depth; and a bridge packer was set from 789 to 931 m slant depth. These changes made it possible to pump water in through the bottom perforations without a contribution of water from the perforations higher in the liner. A pump with an intake at 767 m slant depth and capacity about 30 gpm began operation in mid-September, 1998. MDAs for spectra of samples collected from the CHESHIRE cavity in Sept 1998, Oct 1999, and Jul 2003 are presented in this report.

In May 1987, UE-20n #1 was drilled 300 m SW of CHESHIRE. It was cased and plugged so the interval from 696-866 m bgs could be sampled. The Cs concentration was substantially lower than the U-20n PS-1DDh concentrations, and Sb and Kr were lower as well but ^{3}H was of similar magnitude. During pumping, the pump grated against the side of the pipe, hole UE-20n #1 filled with iron hydroxide, and no more sampling was done. No spectra are included in this report for this more distant well.

DALHART (U-4u PS 2A)

Fired: 13 Oct 88
DOB: 640 m
SWL: 509 m (bgs)
Yield: <150 kT

U-4u PS 2A was drilled in 1990 and a piezometer tube was placed in the hole to a depth of ~ 510 m. Bailer samples collected in 1992-93 indicated stagnant water in the tubing with a ^{3}H activity of 5 x 10^7 Bq/L as well as detectable ^{60}Co, ^{106}Ru, ^{125}Sb, and ^{137}Cs. An unsuccessful attempt was

made to airlift (jet) water out in 1995. In 1998, tandem Bennett pumps were placed in the tube and a 208-L water sample was collected. The sampling was thought to be insufficient to purge the stagnant water, so the sample may not represent ambient groundwater conditions (Thompson et al., 2000). MDAs for spectra of samples collected in Sept 1998 and Oct 2003 are presented in this report.

TYBO/BENHAM (ER-20-5#1 AND ER-20-5#3)

TYBO	BENHAM
Fired: 14 May 75	19 Dec 68
DOB: 765 m	1402 m
SWL: 630 m (bgs)	641 m (bgs)
Yield: 200-1000 kT	1.15 MT

ER-20-5#1 and ER-20-5#3 were drilled between Nov 95 and Feb 96, 280 m SW of TYBO and 1300 m S of BENHAM. ER-20-5#3 is about 30 m south of ER-20-5#1. The depth of the screen in ER-20-5#1 is 701-784 m bgs; in ER-20-5#3, the screen is 1046 - 1183 m bgs. Three samples from Jan 96 to Apr 97 showed evidence of Pu in the water from both holes, though 10^{-2} to 10^{-3} times lower in the deep well (ER-20-5#3). Nearly all of the activities of Co, Cs, Eu, and Pu were associated with filterable colloids. The Pu was proven isotopically to have originated from BENHAM (none from TYBO). Colloidal material was of a natural composition - clays, zeolites and crystobalite. Pu concentrations in ER-20-5#1 were ~ 10^{-14} g/L, lower than the solubility limits for the expected species. This was the first observation of Pu movement over such a long distance. MDAs for spectra of groundwater samples collected from ER-20-5#1 during Jan 1996, Jul 1998, and Nov 2004 and from ER-20-5#3 during Feb 1996, Nov 2001, and Nov 2004 are presented in this report.

ER-12-2

Drilled: Nov. 2002-Dec.2003
Depth: 2098 m
SWL: 65 m (bgs)

This well is not directly associated with a test. The well was drilled from November 2002 to January 2003. The overall purpose of the well was to gather subsurface data to help characterize the hydrogeology in northwestern Yucca Flat. The well was drilled to a depth of 2,098 meters. The 131-centimeter-diameter borehole was left open below the base of the intermediate casing at 902 meters. A piezometer string was installed outside the surface casing to a depth of 176 meters to monitor a zone of perched water (Completion Report for Well ER-12-2, DOE/NV/11718--846). MDAs for spectra of a groundwater sample collected at ER-12-2 in April 2003 are presented in this report.

ER-12-3

Drilled: March-April, 2005
Depth: 1496 m
SWL: 949 m

This well is not directly associated with a test. The well was drilled in March and April 2005. The overall purpose of the well was to gather subsurface data to better characterize the hydrogeology of central Rainier Mesa. The well was drilled to a depth of 1,496 meters. The 131-centimeter-diameter borehole was left open below the base of the intermediate casing at 902 meters (Completion Report for Well ER-12-3, DOE/NV/11718--1182). MDAs for spectra of a groundwater sample collected at ER-12-3 in July 2005 are presented in this report.

U12n-Tunnel

Drilled: 1964-1993
Tests: 22 nuclear, 1 high explosive
Elevation: ~1840 m

U12n tunnel is located in Rainier Mesa and is the largest tunnel in the mesa. It was drilled between 1964 and 1993. Twenty-two nuclear tests and 1 high explosive test were conducted in this tunnel while it was in use. U12n tunnel was closed in 1994 and gas sealed portals and gas sealed doors were installed after wards (Russell et. al., "Evaluation of Monitoring Data from Impounded Water within U12n and U12t Tunnel – Rainier and Aqueduct Mesas, Nevada Test Site", June 2003). Since sealing, the tunnel has filled with water.

The water samples are of water that is impounded within the tunnel and collected from a vent hole. MDAs for spectra of water sampled collected at the vent hole during Aug 2008 and Oct 2011 are presented in this report.

U12t-Tunnel

Drilled: late 1960's-early 1980's
Tests: 6 nuclear
Elevation: ~1710 m

U12t tunnel is located in northeast Rainier Mesa. It was drilled from the early 1960's until the late 1980's. Six nuclear tests were conducted in this tunnel while it was in use. U12t tunnel was closed in 1993 and gas sealed portals and gas sealed doors were installed after wards (Russell et. al., "Evaluation of Monitoring Data from Impounded Water within U12n and U12t Tunnel – Rainier and Aqueduct Mesas, Nevada Test Site", June 2003). Since sealing, the tunnel has filled with water.

The water samples are of water that is impounded within the tunnel and collected adjacent to the gas seal plug or gas seal door. MDAs for spectra of water sampled collected at these two locations in Nov 2006 are presented in this report.

Results

Spectra for two or three samples were identified for most sampling locations. The exceptions were ALMENDRO and the two monitoring wells, ER-12-2 and ER-12-3, for which only one spectra was used. The reason for this was that the post shot hole U-19v PS 1D at ALMENDRO was never pumped, only bailed and only one spectra was available (four bailers were combined to get enough water for the analysis for samples collected in Sept 2000). The spectra were recovered and MDAs were calculated using the Currie equation (Currie, 1968) at the 95% confidence level (2 sigma). At ER-12-2 and ER-12-3, only a few samples were collected, and because the wells are not associated with a test, only one sample per well is used in the analysis presented here. The data for all of the samples are included in the attached pdf file (Hot Well Drum Sample MDAs Table.pdf).

Tables 2 through 13 provide the results of this comparison. As can be seen from the results tables, 26 of the 43 nuclides from the Bowen report have gamma rays from which MDAs are reported. ^{137}Cs also has appropriate gammas, however as noted earlier, it is not included in this study because it is frequently detected and actual sample (detected) concentrations can be used rather than the MDAs. The tables list the MCLs as defined by the EPA for many, but not all, of the radionuclides. The estimated MCLs calculated with RESRAD are also included for comparison. In this study, the comparison of MDAs to MCLs is made first for those radionuclides with MCLs defined by the U.S. EPA (2002) and then separately for MCLs calculated using RESRAD.

Comparison of MDAs to EPA MCLs: The following radionuclides have calculated MDAs that are consistently and considerably below their respective EPA MCLs: ^{150}Eu, ^{152}Eu, ^{154}Eu, ^{166m}Ho, ^{237}Np, ^{241}Am and ^{243}Am. Plots illustrating the MDAs in comparison to the respective EPA MCLs for these 7 radionuclides are provided in Figure 1. ^{152}Eu and ^{154}Eu were each detected in 5 of the 34 samples, but those detected activities are also significantly below their respective MCLs, as shown in Figure 1. The radionuclides with MDAs consistently above the EPA MCL are ^{99}Tc, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Pu, and ^{244}Cm, as shown in Figure 2. The MDAs for ^{129}I and ^{232}Th were close to or exceeded their MCLs in a number of samples, as shown in Figure 3. Although the MDA values for radionuclides shown in Figures 2 and 3 exceed their respective MCLs, it is important to distinguish that it remains an unknown whether the radionuclide is present at activities less than the MDA. Therefore, the radionuclides/samples shown in Figures 2 and 3 would not be excluded using this screening analysis. The order of the points shown in these figures corresponds to the order of the sampling locations and samples provided in Tables 2 through 13.

Comparison of MDAs to MCLs calculated with RESRAD: The following radionuclides have calculated MDAs that are consistently and considerably below their respective MCLs calculated using RESRAD: ^{26}Al, ^{121m}Sn, ^{126}Sn, ^{232}U, ^{233}U, ^{234}U, and ^{235}U. Plots illustrating the MDAs in comparison to the MCLs for these 7 radionuclides are provided in Figure 4. ^{234}U and ^{235}U were detected in 6 of the 34 samples; those activities are provided in Figure 4, and those detected activities are also significantly below the respective MCLs. Figure 5 shows comparisons of the MCLs to the sample MDAs for ^{94}Nb and ^{236}U. For ^{94}Nb, all but one of the sample MDAs are significantly less than the RESRAD-estimated MCL (i.e., the MCL is 870 pCi/L and the samples have activities less than 1 pCi/L). One ^{94}Nb sample from DALHART has an anomalously high MDA (2.2e4) that is thought to be non-representative (Figure 5) and a much lower MDA was obtained for a later sample collected at DALHART; the authors of this report consider ^{94}Nb as falling into the same category of being consistently and considerably lower than its MCL, like those shown in Figure 4. For ^{236}U, most sample MDAs are less than the RESRAD-estimated MCL. One sample from U12t-Tunnel has an anomalously high MDA that is slightly higher than the MCL. Finally, MDAs for ^{238}U are compared to its RESRAD-estimated MCL in Figure 6, and many of the sample MDAs are significantly higher than the MCL, so this method cannot be used to exclude either ^{236}U or ^{238}U from modeling efforts.

The data in the attached tables and plots are provided for modelers to use when evaluating whether specific radionuclides can be excluded from their modeling efforts.

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Table 2

MDAs for ALMENDRO (U-19v PS1d) Pressure Tube Samples

Sample Name:	7910-00-250[3]
Collection Date:	26-Sep-00
Volume (l):	9.1
Fraction Counted :	1

Radionuclide	Main Gamma (keV)	Intensity	Half-life (d)	MCL (pCi/L)	MDA (pCi/L)
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	2.1E-01
^{94}Nb	871.1	1	7.41E+06	*870*	1.5E-01
^{99}Tc	89.6	0.000006	7.71E+07	**900**[2]	1.2E+04
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	3.9E+00
^{126}Sn	87.6	0.37	9.13E+07	*320*	1.9E-01
^{129}I	39.6	0.075	5.73E+09	**1**	9.5E-01
^{150}Eu	334	0.96	1.35E+04	**200**	1.2E-01
^{152}Eu	344.2	0.265	4.95E+03	**200**	4.3E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	5.4E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	1.5E-01
^{232}Th	63.8	0.0026	5.11E+12	**15**	2.2E+01
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	3.1E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	8.0E+01
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	4.5E+01
^{235}U	185.7	0.572	2.57E+11	*65*	1.5E-01
^{236}U	49.4	0.00078	8.55E+09	*1900*	8.1E+01
^{238}U	49.5	0.00064	1.63E+12	***10***	9.9E+01
^{237}Np	86.5	0.124	7.82E+08	**15**	5.6E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**	1.7E+02
^{239}Pu	51.6	0.00027	8.80E+06	**15**	2.3E+02
^{240}Pu	45.2	0.00045	2.40E+06	**15**	1.5E+02
^{241}Pu	103.7	0.000001	5.26E+03	**300**	7.2E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**	1.8E+02
^{241}Am	59.5	0.359	1.58E+05	**15**	1.8E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	1.1E-01
^{244}Cm	42.8	0.00024	6.61E+03	**15**	2.9E+02

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.

(1) MCL calculated using RESRAD *(Italics text)*

(2) MCL from US EPA (EPA, 2002) **(Bold text)**

(3) The water from four 2.2 L pressure tubes was combined to make one sample for gamma analysis

Table 3

MDAs for BILBY (U-3cnPS#2) Drum Samples

					Sample Name:	3552-97-110	3552-01-110	3552-04-110
					Collection Date:	22-Jan-97	18-Dec-01	9-Dec-04
					Volume (l):	208	205	196
					Fraction Counted :	0.16	0.17	0.18
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**		**MDA (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]		6.4E-01	8.4E-02	7.5E-02
^{94}Nb	871.1	1	7.41E+06	*870*		5.9E-01	6.4E-02	6.2E-02
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]		8.1E+04	3.8E+03	4.0E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*		1.1E+02	1.2E+00	1.2E+00
^{126}Sn	87.6	0.37	9.13E+07	*320*		1.3E+00	6.1E-02	6.4E-02
^{129}I	39.6	0.075	5.73E+09	**1**		2.4E+01	3.1E-01	3.1E-01
^{150}Eu	334	0.96	1.35E+04	**200**		4.1E-01	4.4E-02	4.2E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**		1.6E+00	1.7E-01	1.7E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**		2.2E+00	2.0E-01	2.2E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**		5.3E-01	5.6E-02	5.5E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**		3.2E+02	8.4E+00	8.2E+00
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*		4.0E+02	1.1E+01	1.1E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*		1.8E+03	2.6E+01	2.5E+01
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*		7.2E+02	1.6E+01	1.6E+01
^{235}U	185.7	0.572	2.57E+11	*65*		7.1E-01	5.6E-02	5.4E-02
^{236}U	49.4	0.00078	8.55E+09	*1900*		1.2E+03	2.7E+01	2.7E+01
^{238}U	49.5	0.00064	1.63E+12	***10***		1.4E+03	3.7E+01	3.6E+01
^{237}Np	86.5	0.124	7.82E+08	**15**		4.0E+00	1.8E-01	1.9E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**		4.1E+03	6.2E+01	6.1E+01
^{239}Pu	51.6	0.00027	8.80E+06	**15**		3.3E+03	9.1E+01	8.5E+01
^{240}Pu	45.2	0.00045	2.40E+06	**15**		3.0E+03	5.3E+01	5.2E+01
^{241}Pu	103.7	0.000001	5.26E+03	**300**		4.5E+05	2.5E+04	2.4E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**		3.9E+03	6.2E+01	6.1E+01
^{241}Am	59.5	0.359	1.58E+05	**15**		2.2E+00	7.2E-02	7.1E-02
^{243}Am	74.7	0.68	2.69E+06	**15**		9.0E-01	3.4E-02	3.3E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**		6.6E+03	9.2E+01	8.8E+01

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 4

MDAs for BULLION (ER20-6#1, ER20-6#2, ER20-6#3) Drum Samples

				Sample Name:		2061-96-110	2062-96-110	2063-96-110
				Collection Date:		17-Dec-96	27-Nov-96	16-Dec-96
				Volume (l):		198	205	200
				Fraction Counted :		0.19	0.22	0.24
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**		**MDA (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]		5.2E-02	3.9E-02	3.6E-02
^{94}Nb	871.1	1	7.41E+06	*870*		3.7E-02	3.4E-02	3.2E-02
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]		2.7E+03	2.5E+03	2.4E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*		9.1E-01	8.3E-01	7.5E-01
^{126}Sn	87.6	0.37	9.13E+07	*320*		4.5E-02	4.1E-02	3.8E-02
^{129}I	39.6	0.075	5.73E+09	**1**		2.3E-01	2.0E-01	1.9E-01
^{150}Eu	334	0.96	1.35E+04	**200**		2.8E-02	2.5E-02	2.4E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**		1.0E-01	9.0E-02	8.5E-02
^{154}Eu	1274.4	0.352	3.14E+03	**60**		1.3E-01	1.1E-01	1.1E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**		3.5E-02	3.1E-02	2.9E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**		5.2E+00	6.4E+00	4.6E+00
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*		7.4E+00	6.7E+00	6.5E+00
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*		1.9E+01	1.7E+01	1.6E+01
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*		1.0E+01	1.2E+01	1.1E+01
^{235}U	185.7	0.572	2.57E+11	*65*		3.6E-02	3.2E-02	2.9E-02
^{236}U	49.4	0.00078	8.55E+09	*1900*		1.9E+01	1.7E+01	1.6E+01
^{238}U	49.5	0.00064	1.63E+12	*10*		2.3E+01	2.1E+01	2.0E+01
^{237}Np	86.5	0.124	7.82E+08	**15**		1.3E-01	1.2E-01	1.1E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**		4.0E+01	3.6E+01	3.4E+01
^{239}Pu	51.6	0.00027	8.80E+06	**15**		5.4E+01	5.0E+01	4.7E+01
^{240}Pu	45.2	0.00045	2.40E+06	**15**		3.4E+01	3.2E+01	3.0E+01
^{241}Pu	103.7	0.000001	5.26E+03	**300**		1.7E+04	1.5E+04	1.4E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**		4.3E+01	4.0E+01	3.7E+01
^{241}Am	59.5	0.359	1.58E+05	**15**		4.2E-02	3.9E-02	3.6E-02
^{243}Am	74.7	0.68	2.69E+06	**15**		2.2E-02	2.5E-02	2.3E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**		6.6E+01	6.0E+01	5.7E+01

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 5

MDAs for CAMBRIC (RNM-1) Drum Samples

				Sample Name:	434-7-94-002	4341-00-130	4341-04-110
				Collection Date:	13-Sep-94	28-Jun-00	3-Jun-04
				Volume (l):	208	213	209
				Fraction Counted :	0.17	0.16	0.16
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	5.9E-02	2.2E-07	7.6E-13
^{94}Nb	871.1	1	7.41E+06	*870*	4.3E-02	1.6E-07	5.5E-13
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]	2.9E+03	1.1E-02	3.8E-08
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	1.2E+00	4.5E-06	1.6E-11
^{126}Sn	87.6	0.37	9.13E+07	*320*	4.7E-02	1.8E-07	6.1E-13
^{129}I	39.6	0.075	5.73E+09	**1**	2.6E-01	9.9E-07	3.4E-12
^{150}Eu	334	0.96	1.35E+04	**200**	3.6E-02	1.3E-07	4.6E-13
^{152}Eu	344.2	0.265	4.95E+03	**200**	1.3E-01	4.8E-07	1.6E-12
^{154}Eu	1274.4	0.352	3.14E+03	**60**	1.4E-01	5.4E-07	1.9E-12
^{166m}Ho	184.4	0.726	4.38E+05	**90**	4.9E-02	1.8E-07	6.3E-13
^{232}Th	63.8	0.0026	5.11E+12	**15**	7.7E+00	2.9E-05	9.9E-11
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	1.1E+01	4.1E-05	1.4E-10
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	2.6E+01	9.7E-05	3.3E-10
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	1.5E+01	5.5E-05	1.9E-10
^{235}U	185.7	0.572	2.57E+11	*65*	4.6E-02	1.7E-07	5.9E-13
^{236}U	49.4	0.00078	8.55E+09	*1900*	2.7E+01	1.0E-04	3.5E-10
^{238}U	49.5	0.00064	1.63E+12	***10***	3.3E+01	1.2E-04	4.2E-10
^{237}Np	86.5	0.124	7.82E+08	**15**	1.4E-01	5.3E-07	1.8E-12
^{238}Pu	43.5	0.000395	3.20E+04	**15**	5.6E+01	2.1E-04	7.3E-10
^{239}Pu	51.6	0.00027	8.80E+06	**15**	7.5E+01	2.8E-04	9.7E-10
^{240}Pu	45.2	0.00045	2.40E+06	**15**	5.5E+01	2.1E-04	7.1E-10
^{241}Pu	103.7	0.000001	5.26E+03	**300**	2.3E+04	8.7E-02	3.0E-07
^{242}Pu	44.9	0.00036	1.37E+08	**15**	6.2E+01	2.3E-04	8.1E-10
^{241}Am	59.5	0.359	1.58E+05	**15**	6.3E-02	2.3E-07	8.1E-13
^{243}Am	74.7	0.68	2.69E+06	**15**	3.1E-02	1.2E-07	4.0E-13
^{244}Cm	42.8	0.00024	6.61E+03	**15**	9.2E+01	3.5E-04	1.2E-09

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 6

MDAs for CAMEMBERT (U-19q PS 1D) Drum Samples

				Sample Name:	840-98-180	840-98-170	8400-03-110
				Collection Date:	21-Oct-98	21-Oct-98	16-Jul-03
				Volume (l):	201	210	210
				Fraction Counted :	0.06	0.07	0.03

Radionuclide	Main Gamma (keV)	Intensity	Half-life (d)	MCL (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	1.4E-01	1.3E-01	3.3E-01
^{94}Nb	871.1	1	7.41E+06	*870*	1.5E-01	1.4E-01	3.2E-01
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]	1.5E+04	1.3E+04	2.9E+04
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	1.3E-01	2.1E-01	2.7E-01
^{126}Sn	87.6	0.37	9.13E+07	*320*	2.6E-01	2.2E-01	5.1E-01
^{129}I	39.6	0.075	5.73E+09	**1**	3.1E-02	4.8E-02	6.4E-02
^{150}Eu	334	0.96	1.35E+04	**200**	1.3E-01	1.0E-01	2.4E-01
^{152}Eu	344.2	0.265	4.95E+03	**200**	4.5E-01	3.8E-01	8.8E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	4.5E-01	4.0E-01	9.1E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	1.4E-01	1.2E-01	2.8E-01
^{232}Th	63.8	0.0026	5.11E+12	**15**	4.2E+01	4.7E+01	1.0E+02
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	6.3E+01	7.4E+01	1.3E+02
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	2.5E+00	3.8E+00	5.1E+00
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	1.1E+02	1.4E+02	2.3E+02
^{235}U	185.7	0.572	2.57E+11	*65*	1.6E-01	1.3E-01	3.1E-01
^{236}U	49.4	0.00078	8.55E+09	*1900*	1.3E+02	1.8E+02	3.0E+02
^{238}U	49.5	0.00064	1.63E+12	*10*	1.6E+02	2.2E+02	3.7E+02
^{237}Np	86.5	0.124	7.82E+08	**15**	6.6E-01	7.1E-01	1.6E+00
^{238}Pu	43.5	0.000395	3.20E+04	**15**	5.3E+00	7.9E+00	1.1E+01
^{239}Pu	51.6	0.00027	8.80E+06	**15**	5.1E+02	6.6E+02	1.1E+03
^{240}Pu	45.2	0.00045	2.40E+06	**15**	4.5E+00	6.5E+00	9.1E+00
^{241}Pu	103.7	0.000001	5.26E+03	**300**	8.3E+04	7.2E+04	1.6E+05
^{242}Pu	44.9	0.00036	1.37E+08	**15**	5.6E+00	8.2E+00	1.1E+01
^{241}Am	59.5	0.359	1.58E+05	**15**	3.4E-01	3.9E-01	7.1E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	1.4E-01	1.4E-01	3.4E-01
^{244}Cm	42.8	0.00024	6.61E+03	**15**	8.9E+00	1.3E+01	1.8E+01

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 7

MDAs for CHANCELLOR (U-19ad PS 1A) Drum Samples

				Sample Name:	7011-04-160	7011-04-170	7011-08-150
				Collection Date:	27-Sep-04	27-Sep-04	1-May-08
				Volume (l):	196	217	202
				Fraction Counted :	0.08	0.1	0.12
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	1.2E-01	8.8E-02	8.3E-02
^{94}Nb	871.1	1	7.41E+06	*870*	1.0E-01	6.7E-02	6.4E-02
^{99}Tc	89.6	6E-06	7.71E+07	**900** [2]	8.3E+03	5.9E+03	5.2E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	2.2E+00	1.6E+00	1.4E+00
^{126}Sn	87.6	0.37	9.13E+07	*320*	1.3E-01	9.9E-02	8.4E-02
^{129}I	39.6	0.075	5.73E+09	**1**	6.0E-01	4.2E-01	3.7E-01
^{150}Eu	334	0.96	1.35E+04	**200**	7.8E-02	5.7E-02	4.7E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**	2.9E-01	2.1E-01	1.7E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	3.2E-01	2.3E-01	2.2E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	8.9E-02	6.4E-02	5.6E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**	1.4E+01	1.0E+01	8.9E+00
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	2.0E+01	1.4E+01	1.3E+01
^{233}U	42.4	0.0009	5.81E+07	*2.9E+05*	4.9E+01	3.5E+01	3.1E+01
^{234}U	53.2	0.0012	8.99E+07	*1.9E+05*	3.6E+01	2.5E+01	2.3E+01
^{235}U	185.7	0.572	2.57E+11	*65*	9.9E-02	7.1E-02	6.0E-02
^{236}U	49.4	0.0008	8.55E+09	*1900*	5.3E+01	3.8E+01	3.2E+01
^{238}U	49.5	0.0006	1.63E+12	***10***	6.4E+01	4.7E+01	3.9E+01
^{237}Np	86.5	0.124	7.82E+08	**15**	3.6E-01	2.6E-01	2.2E-01
^{238}Pu	43.5	0.0004	3.20E+04	**15**	1.1E+02	7.9E+01	6.6E+01
^{239}Pu	51.6	0.0003	8.80E+06	**15**	1.5E+02	1.1E+02	9.5E+01
^{240}Pu	45.2	0.0005	2.40E+06	**15**	9.9E+01	7.2E+01	6.2E+01
^{241}Pu	103.7	1E-06	5.26E+03	**300**	4.6E+04	3.3E+04	2.9E+04
^{242}Pu	44.9	0.0004	1.37E+08	**15**	1.2E+02	8.5E+01	7.4E+01
^{241}Am	59.5	0.359	1.58E+05	**15**	1.1E-01	8.2E-02	7.2E-02
^{243}Am	74.7	0.68	2.69E+06	**15**	6.9E-02	5.0E-02	3.6E-02
^{244}Cm	42.8	0.0002	6.61E+03	**15**	1.8E+02	1.3E+02	1.1E+02

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 8

MDAs for CHESHIRE (U-20n PS 1D) Drum Samples

	Sample Name:	8521-98-180	8521-99-140	8521-03-110
	Collection Date:	21-Sep-98	12-Oct-99	9-Jul-03
	Volume (l):	208	212	205
	Fraction Counted :	0.18	0.24	0.27

Radionuclide	Main Gamma (keV)	Intensity	Half-life (d)	MCL (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	5.5E-02	3.7E-02	3.0E-02
^{94}Nb	871.1	1	7.41E+06	*870*	4.3E-02	3.1E-02	3.1E-02
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]	3.0E+03	2.1E+03	2.9E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	9.6E-01	6.8E-01	3.0E-02
^{126}Sn	87.6	0.37	9.13E+07	*320*	4.7E-02	3.4E-02	5.0E-02
^{129}I	39.6	0.075	5.73E+09	**1**	2.3E-01	1.7E-01	7.1E-03
^{150}Eu	334	0.96	1.35E+04	**200**	2.9E-02	2.2E-02	2.4E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**	Detected	Detected	Detected
^{154}Eu	1274.4	0.352	3.14E+03	**60**	Detected	Detected	Detected
^{166m}Ho	184.4	0.726	4.38E+05	**90**	3.9E-02	2.8E-02	2.9E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**	5.6E+00	4.0E+00	9.1E+00
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	8.9E+00	5.7E+00	1.4E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	2.0E+01	1.4E+01	5.7E-01
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	1.1E+01	8.1E+00	2.5E+01
^{235}U	185.7	0.572	2.57E+11	*65*	3.7E-02	2.7E-02	3.1E-02
^{236}U	49.4	0.00078	8.55E+09	*1900*	2.0E+01	1.5E+01	3.1E+01
^{238}U	49.5	0.00064	1.63E+12	*10*	2.4E+01	1.8E+01	3.8E+01
^{237}Np	86.5	0.124	7.82E+08	**15**	1.4E-01	1.0E-01	1.6E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**	4.2E+01	3.0E+01	1.2E+00
^{239}Pu	51.6	0.00027	8.80E+06	**15**	5.8E+01	4.0E+01	1.1E+02
^{240}Pu	45.2	0.00045	2.40E+06	**15**	3.7E+01	2.9E+01	1.0E+00
^{241}Pu	103.7	0.000001	5.26E+03	**300**	1.8E+04	1.5E+04	1.6E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**	4.6E+01	3.4E+01	1.3E+00
^{241}Am	59.5	0.359	1.58E+05	**15**	4.6E-02	3.3E-02	7.3E-02
^{243}Am	74.7	0.68	2.69E+06	**15**	2.3E-02	1.6E-02	3.1E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**	7.1E+01	5.0E+01	2.0E+00

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 9

MDAs for DALHART (U-4u PS 2A) Drum Samples

			Sample Name:		1112-98-120	1112-03-110	1112-03-130
			Collection Date:		23-Sep-98	9-Oct-03	9-Oct-03
			Volume (l):		202	159	176
			Fraction Counted :		0.04	0.05	0.04
Radionuclide	Main Gamma (keV)	Intensity	Half-life (d)	MCL (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)
^{26}Al	1808.7	0.9976	2.62E+08	*420* [1]	1.8E-01	1.9E-01	2.0E-01
^{94}Nb	871.1	1	7.41E+06	*870*	2.2E+04	2.0E-01	2.2E-01
^{99}Tc	89.6	0.000006	7.71E+07	**900** [2]	5.0E-01	2.2E+04	2.6E+04
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	3.3E+01	3.3E+01	3.7E+01
^{126}Sn	87.6	0.37	9.13E+07	*320*	2.4E-01	2.3E-01	2.8E-01
^{129}I	39.6	0.075	5.73E+09	**1**	7.2E+00	7.1E+00	8.1E+00
^{150}Eu	334	0.96	1.35E+04	**200**	1.5E-01	1.5E-01	1.7E-01
^{152}Eu	344.2	0.265	4.95E+03	**200**	5.4E-01	5.6E-01	6.1E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	4.9E-01	4.6E-01	5.7E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	1.9E-01	1.9E-01	2.1E-01
^{232}Th	63.8	0.0026	5.11E+12	**15**	6.3E+01	6.2E+01	7.3E+01
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	1.3E+02	1.3E+02	1.5E+02
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	5.4E+02	5.4E+02	6.1E+02
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	2.4E+02	2.4E+02	2.7E+02
^{235}U	185.7	0.572	2.57E+11	*65*	1.9E-01	1.9E-01	2.1E-01
^{236}U	49.4	0.00078	8.55E+09	*1900*	4.3E+02	4.2E+02	4.8E+02
^{238}U	49.5	0.00064	1.63E+12	*10*	5.2E+02	5.1E+02	5.9E+02
^{237}Np	86.5	0.124	7.82E+08	**15**	7.2E-01	7.0E-01	8.4E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**	1.1E+03	1.1E+03	1.3E+03
^{239}Pu	51.6	0.00027	8.80E+06	**15**	1.2E+03	1.1E+03	1.3E+03
^{240}Pu	45.2	0.00045	2.40E+06	**15**	9.0E+02	9.1E+02	1.0E+03
^{241}Pu	103.7	0.000001	5.26E+03	**300**	1.1E+05	1.1E+05	1.3E+05
^{242}Pu	44.9	0.00036	1.37E+08	**15**	1.2E+03	1.2E+03	1.3E+03
^{241}Am	59.5	0.359	1.58E+05	**15**	6.9E-01	6.9E-01	7.7E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	1.8E-01	1.7E-01	2.1E-01
^{244}Cm	42.8	0.00024	6.61E+03	**15**	1.9E+03	1.9E+03	2.1E+03

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 10

MDAs for TYDO BENHAM (ER20-5#1, ER20-5#3) Drum Samples

					ER20-5#1			ER20-5#3		
				Sample Name:	205-11-901	2051-98-130	2051-04-160	205-31-901	2053-01-110	2053-04-160
				Collection Date:	3-Jan-96	9-Jul-98	30-Nov-04	15-Feb-96	15-Nov-01	30-Nov-04
				Volume (l):	205	210	214	215	211	212
				Fraction Counted :	0.14	0.13	0.17	0.11	0.11	0.12
Radionuclide	Main Gamma (keV)	Intensity	Half-life (d)	MCL (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)	MDA (pCi/L)
^{26}Al	1808.7	0.9976	2.62E+08	*420* (1)	1.4E-01	1.5E-01	1.1E-01	1.5E-01	1.5E-01	1.4E-01
^{91}Nb	871.1	1	7.41E+06	*870*	8.0E-02	7.8E-02	7.4E-02	8.8E-02	8.5E-02	8.1E-02
^{99}Tc	89.5	0.000006	7.71E+07	**900** (2)	3.1E+03	3.2E+03	2.7E+03	4.1E+03	4.0E+03	3.6E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3300*	~BER	~BER	2.1E+00	~BER	~BER	2.9E+00
^{126}Sn	87.6	0.37	9.13E+07	*320*	8.8E-02	8.5E-02	7.2E-02	9.5E-02	9.2E-02	8.9E-02
^{129}I	39.6	0.075	5.73E+09	**1**	~BER	~BER	6.1E-02	~BER	~BER	8.3E-02
^{150}Eu	334	0.96	1.35E+04	**200**	5.5E-02	5.3E-02	5.2E-02	7.1E-02	6.9E-02	5.5E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**	Det	Det	Det	1.9E-01	1.9E-01	1.6E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	Det	Det	Det	4.2E-01	5.5E-01	3.7E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	6.6E-02	6.5E-02	6.3E-02	7.4E-02	7.5E-02	7.2E-02
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	1.8E+01	1.8E-01	1.5E+01	2.1E+01	2.2E+01	2.0E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	3.8E+01	4.0E-01	3.6E+01	4.3E+01	4.7E+01	4.4E+01
^{236}U	49.4	0.00078	8.55E+09	*1.9E+05*	3.9E+01	4.1E-01	3.7E+01	4.2E+01	4.9E+01	4.4E+01
^{237}Np	86.5	0.124	7.82E+08	**15**	3.3E 01	3.5E 01	2.9E 01	3.9E 01	3.8E 01	3.6E 01
^{236}Pu	43.5	0.000395	3.20E+04	**15**	9.4E+01	9.2E-01	8.8E+01	9.3E+01	9.9E+01	9.6E+01
^{239}Pu	51.6	0.00027	8.80E+06	**15**	1.2E+02	1.3E-02	1.1E+02	1.3E+02	1.3E+02	1.3E+02
^{240}Pu	45.2	0.00045	2.40E+06	**15**	5.5E+01	5.7E-01	5.2E+01	6.0E+01	6.1E+01	5.8E+01
^{241}Pu	103.7	0.000001	5.26E+03	**300**	2.5E+04	2.5E-04	2.3E+04	2.7E+04	2.7E+04	2.6E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**	7.5E+01	8.0E-01	7.4E+01	8.4E+01	8.6E+01	8.2E+01
^{241}Am	59.5	0.359	1.58E+05	**15**	9.7E-02	9.6E-02	9.3E-02	1.0E+00	1.1E+00	9.5E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	6.8E-02	6.0E-02	5.9E-02	7.5E-02	8.1E-02	7.2E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**	1.2E+02	1.3E-02	1.1E+02	1.4E+02	1.4E+02	1.3E+02

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
DET = Detected in sample
~BER = Below energy range of counter
(1) MCL calculated using RESRAD (Italics text)
(2) MCL from US EPA (EPA, 2001) (Bold text)

Table 11

MDAs for ER-12-2 and ER-12-3 Drum Samples

					ER-12-2	ER-12-3
				Sample Name:	1220-03-110	1230-05-110
				Collection Date:	4/1/2003	7/6/2005
				Volume (l):	207	216
				Fraction Counted :	0.20	0.29
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* (1)	6.5E-04	2.3E-09
^{94}Nb	871.1	1	7.41E+06	*870*	6.5E-04	2.3E-09
^{99}Tc	89.6	0.000006	7.71E+07	**900** (2)	3.0E+02	1.0E-03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	1.0E-01	3.5E-07
^{126}Sn	87.6	0.37	9.13E+07	*320*	4.6E-03	1.6E-08
^{129}I	39.6	0.075	5.73E+09	**1**	2.5E-02	8.6E-08
^{150}Eu	334	0.96	1.35E+04	**200**	1.3E-03	4.5E-09
^{152}Eu	344.2	0.265	4.95E+03	**200**	4.6E-03	1.6E-08
^{154}Eu	1274.4	0.352	3.14E+03	**60**	1.3E-03	4.5E-09
^{166m}Ho	184.4	0.726	4.38E+05	**90**	2.6E-03	9.0E-09
^{232}Th	63.8	0.0026	5.11E+12	**15**	5.6E-01	1.9E-06
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	7.7E-01	2.6E-06
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	1.9E+00	6.5E-06
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	1.2E+00	4.0E-06
^{235}U	185.7	0.572	2.57E+11	*65*	2.6E-03	9.0E-09
^{236}U	49.4	0.00078	8.55E+09	*1900*	1.9E+00	6.7E-06
^{238}U	49.5	0.00064	1.63E+12	***10***	2.4E+00	8.2E-06
^{237}Np	86.5	0.124	7.82E+08	**15**	1.4E-02	5.0E-08
^{238}Pu	43.5	0.000395	3.20E+04	**15**	4.1E+00	1.4E-05
^{239}Pu	51.6	0.00027	8.80E+06	**15**	6.4E+00	2.2E-05
^{240}Pu	45.2	0.00045	2.40E+06	**15**	3.7E+00	1.3E-05
^{241}Pu	103.7	0.000001	5.26E+03	**300**	1.8E+03	6.1E-03
^{242}Pu	44.9	0.00036	1.37E+08	**15**	4.5E+00	1.5E-05
^{241}Am	59.5	0.359	1.58E+05	**15**	4.6E-03	1.6E-08
^{243}Am	74.7	0.68	2.69E+06	**15**	2.6E-03	9.0E-09
^{244}Cm	42.8	0.00024	6.61E+03	**15**	6.8E+00	2.3E-05

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 12

MDAs for N Tunnel Samples

					U-12n Vent hole #2	
				Sample Name:	1202-11-110	1215-08-110
				Collection Date:	5-Oct-11	21-Aug-08
				Volume (l):	19.8	17.5
				Fraction Counted :	0.75	0.89
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* (1)	1.4E-01	1.3E-01
^{94}Nb	871.1	1	7.41E+06	*870*	1.0E-01	9.2E-02
^{99}Tc	89.6	0.000006	7.71E+07	**900** (2)	7.4E+03	7.0E+03
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	2.5E+00	2.3E+00
^{126}Sn	87.6	0.37	9.13E+07	*320*	1.2E-01	1.1E-01
^{129}I	39.6	0.075	5.73E+09	**1**	6.0E-01	5.7E-01
^{150}Eu	334	0.96	1.35E+04	**200**	7.7E-02	7.3E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**	2.8E-01	2.6E-01
^{154}Eu	1274.4	0.352	3.14E+03	**60**	3.2E-01	3.4E-01
^{166m}Ho	184.4	0.726	4.38E+05	**90**	9.8E-02	9.4E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**	1.4E+01	1.3E+01
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	2.0E+01	1.9E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	5.0E+01	4.8E+01
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	3.5E+01	2.7E+01
^{235}U	185.7	0.572	2.57E+11	*65*	9.4E-02	9.1E-02
^{236}U	49.4	0.00078	8.55E+09	*1900*	5.1E+01	4.8E+01
^{238}U	49.5	0.00064	1.63E+12	***10***	6.3E+01	5.9E+01
^{237}Np	86.5	0.124	7.82E+08	**15**	3.6E-01	3.4E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**	1.1E+02	1.0E+02
^{239}Pu	51.6	0.00027	8.80E+06	**15**	1.4E+02	1.4E+02
^{240}Pu	45.2	0.00045	2.40E+06	**15**	9.9E+01	9.4E+01
^{241}Pu	103.7	0.000001	5.26E+03	**300**	4.5E+04	4.2E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**	1.2E+02	1.1E+02
^{241}Am	59.5	0.359	1.58E+05	**15**	1.2E-01	1.1E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	5.9E-02	6.7E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**	1.8E+02	1.7E+02

Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.
(1) MCL calculated using RESRAD *(Italics text)*
(2) MCL from US EPA (EPA, 2002) **(Bold text)**

Table 13

MDAs for T-Tunnel Drum Samples

					U-12t gsd	U-12t gsp
				Sample Name:	1280-06-130	1290-06-130
				Collection Date:	1-Nov-06	1-Nov-06
				Volume (l):	188	195
				Fraction Counted :	0.13	0.49
Radionuclide	**Main Gamma (keV)**	**Intensity**	**Half-life (d)**	**MCL (pCi/L)**	**MDA (pCi/L)**	**MDA (pCi/L)**
^{26}Al	1808.7	0.9976	2.62E+08	*420* (1)	7.1E-02	2.1E-02
^{94}Nb	871.1	1	7.41E+06	*870*	6.1E-02	1.5E-01
^{99}Tc	89.6	0.000006	7.71E+07	**900** (2)	8.7E+03	1.5E-02
^{121m}Sn	37.1	0.019	2.01E+04	*3900*	1.5E+03	2.3E+03
^{126}Sn	87.6	0.37	9.13E+07	*320*	1.5E-01	3.9E-02
^{129}I	39.6	0.075	5.73E+09	**1**	2.0E+02	5.2E+01
^{150}Eu	334	0.96	1.35E+04	**200**	4.2E-02	1.1E-02
^{152}Eu	344.2	0.265	4.95E+03	**200**	1.7E-01	4.2E-02
^{154}Eu	1274.4	0.352	3.14E+03	**60**	2.1E-01	5.2E-02
^{166m}Ho	184.4	0.726	4.38E+05	**90**	5.3E-02	1.4E-02
^{232}Th	63.8	0.0026	5.11E+12	**15**	6.0E+01	1.5E+01
^{232}U	57.8	0.002	2.52E+04	*6.7E+08*	1.6E+02	4.3E+01
^{233}U	42.4	0.00086	5.81E+07	*2.9E+05*	7.8E+03	2.1E+03
^{234}U	53.2	0.00123	8.99E+07	*1.9E+05*	6.7E+02	1.7E+02
^{235}U	185.7	0.572	2.57E+11	*65*	5.9E-02	1.6E-02
^{236}U	49.4	0.00078	8.55E+09	*1900*	1.9E+03	5.0E+02
^{238}U	49.5	0.00064	1.63E+12	***10***	2.6E+03	6.6E+02
^{237}Np	86.5	0.124	7.82E+08	**15**	4.6E-01	1.2E-01
^{238}Pu	43.5	0.000395	3.20E+04	**15**	1.5E+04	3.9E+03
^{239}Pu	51.6	0.00027	8.80E+06	**15**	4.0E+03	1.0E+03
^{240}Pu	45.2	0.00045	2.40E+06	**15**	9.0E+03	2.4E+03
^{241}Pu	103.7	0.000001	5.26E+03	**300**	4.5E+04	1.1E+04
^{242}Pu	44.9	0.00036	1.37E+08	**15**	1.1E+04	2.8E+03
^{241}Am	59.5	0.359	1.58E+05	**15**	7.8E-01	2.0E-01
^{243}Am	74.7	0.68	2.69E+06	**15**	1.3E-01	3.4E-02
^{244}Cm	42.8	0.00024	6.61E+03	**15**	2.6E+04	6.7E+03

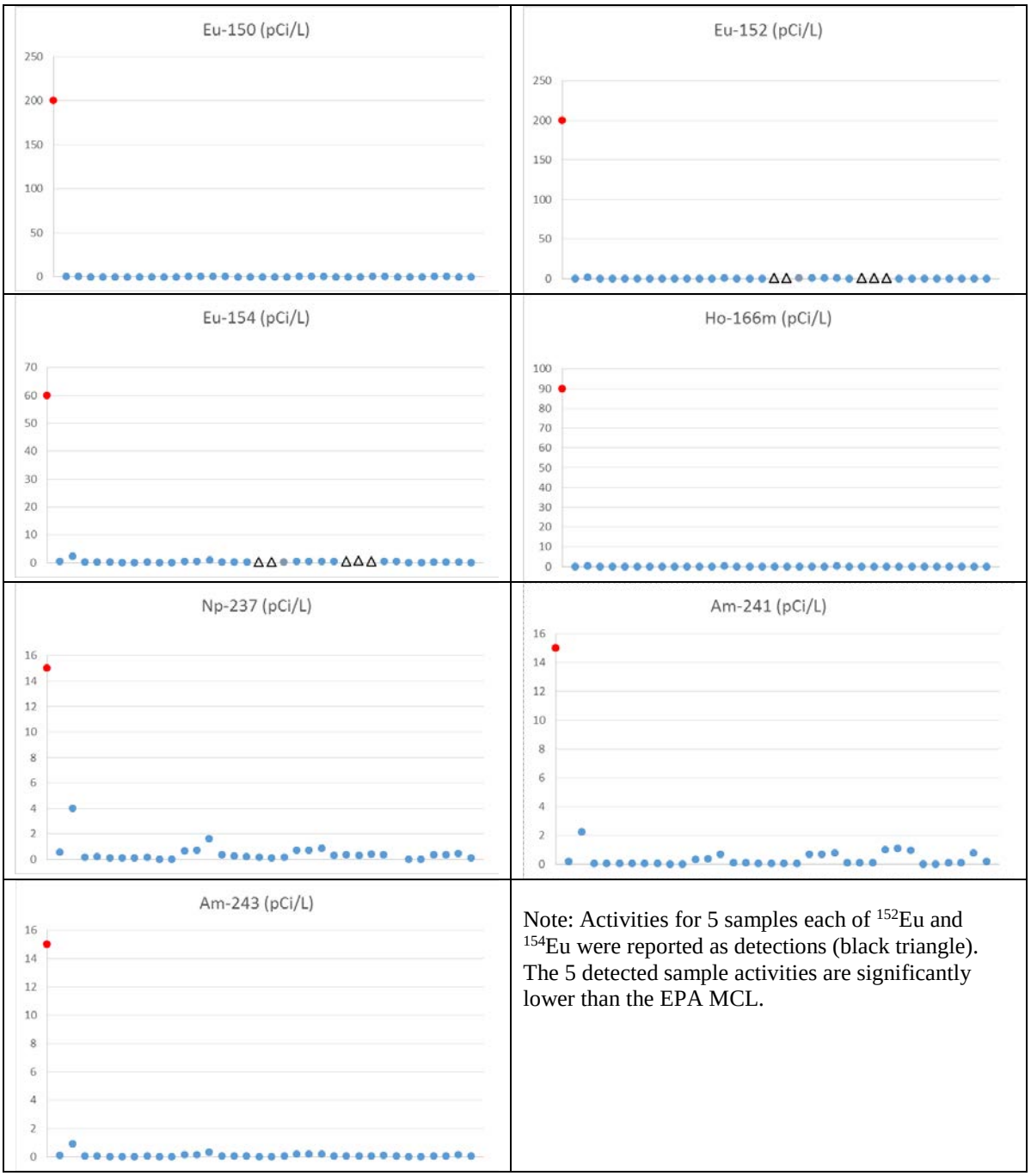
Note: MDA dependent upon counter used, count length, size of sample, other activity present, interferences, etc.

U-12t gsp = gas sealed plug

U-12t gsd = gas sealed door

(1) MCL calculated using RESRAD *(Italics text)*

(2) MCL from US EPA (EPA, 2002) **(Bold text)**



Note: Activities for 5 samples each of ^{152}Eu and ^{154}Eu were reported as detections (black triangle). The 5 detected sample activities are significantly lower than the EPA MCL.

Figure 1: EPA MCLs (red dot) and MDAs for all samples (blue dots) for radionuclides for which all MDAs are lower than the respective MCL. These radionuclides are ^{150}Eu, ^{152}Eu, ^{154}Eu, ^{166m}Ho, ^{237}Np, ^{241}Am and ^{243}Am.

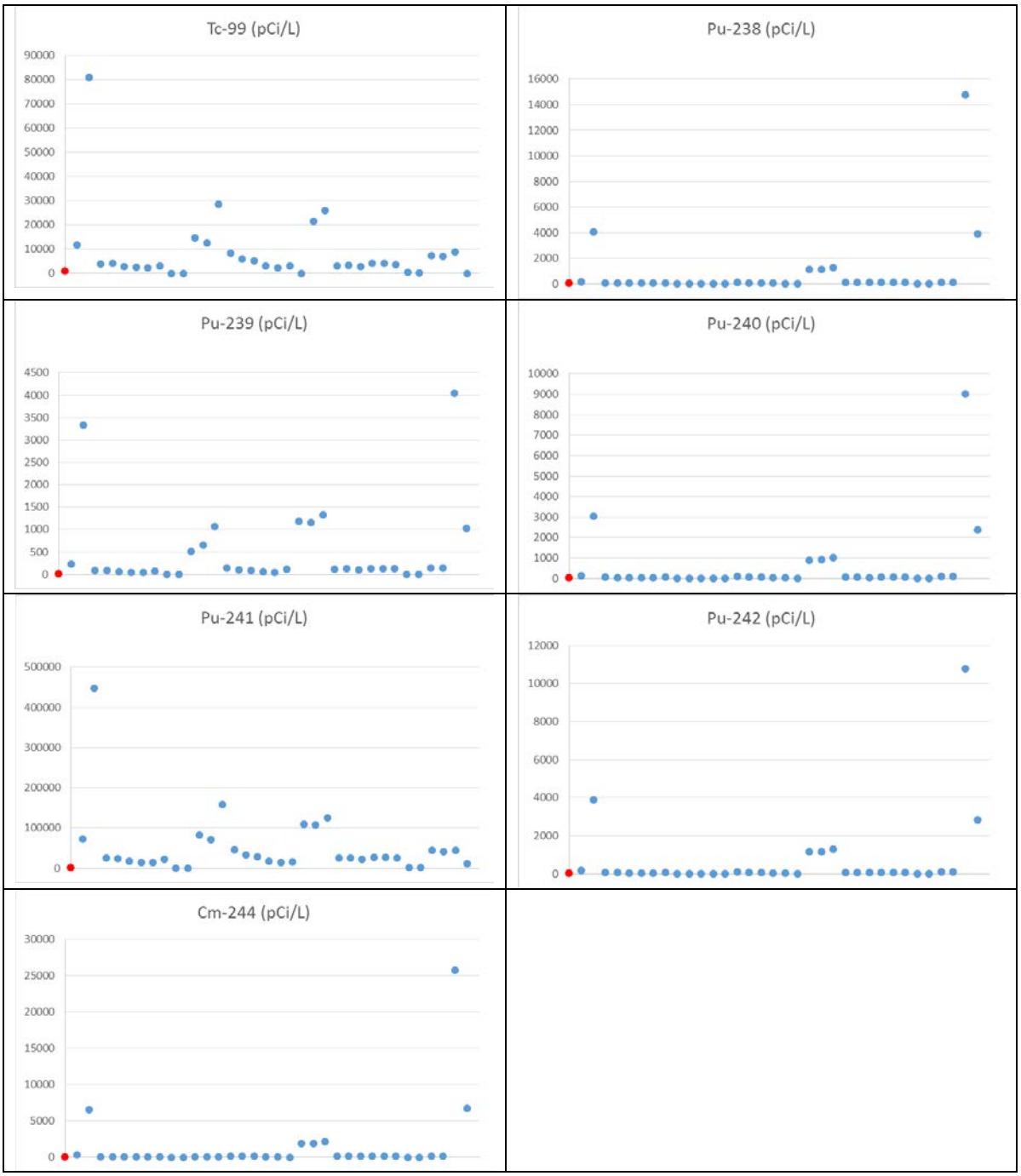


Figure 2: EPA MCLs (red dot) and MDAs for all samples (blue dots) for radionuclides for which the MDAs are consistently above the MCL. These radionuclides are ^{99}Tc, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, and ^{244}Cm.

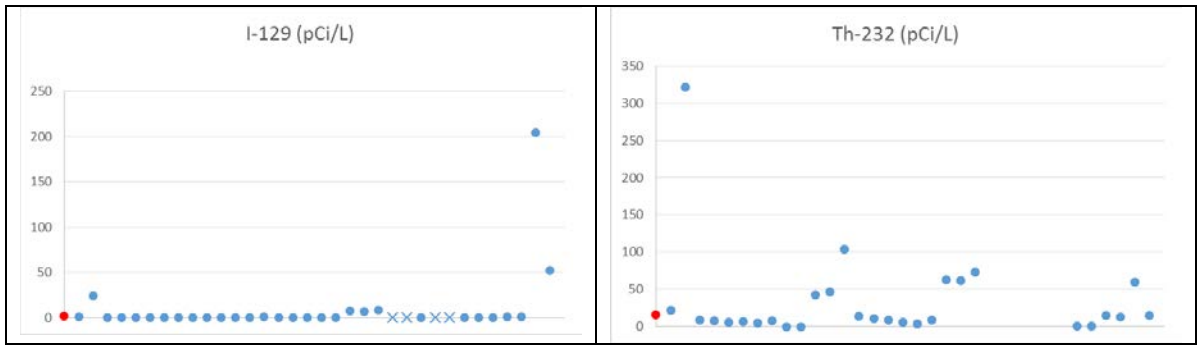


Figure 3: EPA MCLs (red dot) and MDAs for all samples (blue dots) for radionuclides for which the MDAs are similar to or above the MCL. These radionuclides are ^{129}I and ^{232}Th. ^{129}I samples with spectra below the energy range of the counter (blue X) also included (value plotted as zero).

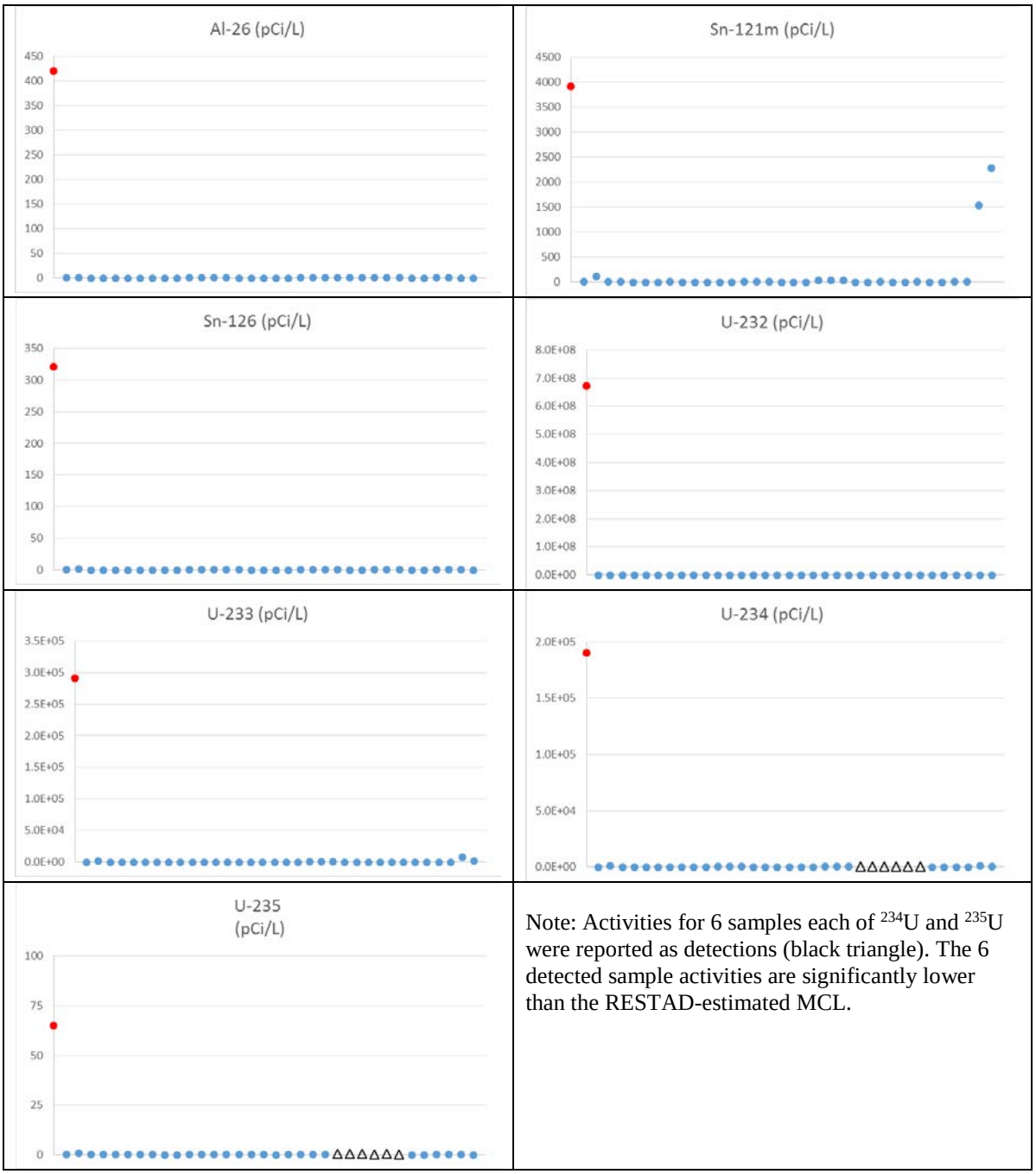


Figure 4: MCLs estimated using RESRAD (red dot) and MDAs for all samples (blue dots) for radionuclides for which nearly all MDAs are lower than the respective MCL. These radionuclides are ^{26}Al, ^{121m}Sn, ^{126}Sn, ^{232}U, ^{233}U, ^{234}U, and ^{235}U.

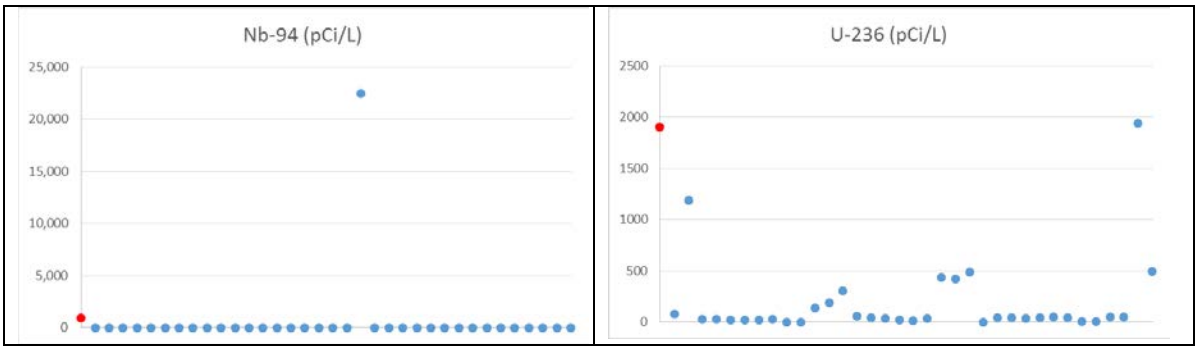


Figure 5: MCLs estimated using RESRAD (red dot) and MDAs for all samples (blue dots) for radionuclides for which all but one MDA are lower than the respective MCL. These radionuclides are ^{94}Nb and ^{236}U.

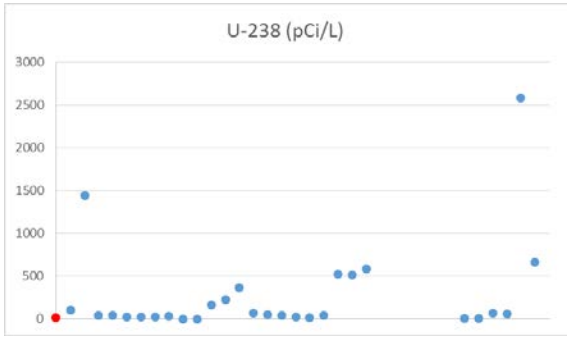


Figure 6: MCL estimated using RESRAD (red dot) and MDAs for all samples (blue dots) for ^{238}U for which many of the MDAs are greater than the MCL.